LA-UR-21-27851
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Title: Neutron Detection Efficiency Measurements of the Domino Detector for the NEMO Experiment

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Intended for: Keepin Program end-of-summer presentations

Issued: 2021-08-05

Neutron Detection Efficiency Measurements of the Domino Detector for the NEMO Experiment

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Summer Fun

Christian Young (ISR-1)

- Educational Background
  - Purdue University, 2020
    - B.S. Nuclear Engineering
  - University of Tennessee, 2025?
    - Ph.D. Nuclear Engineering

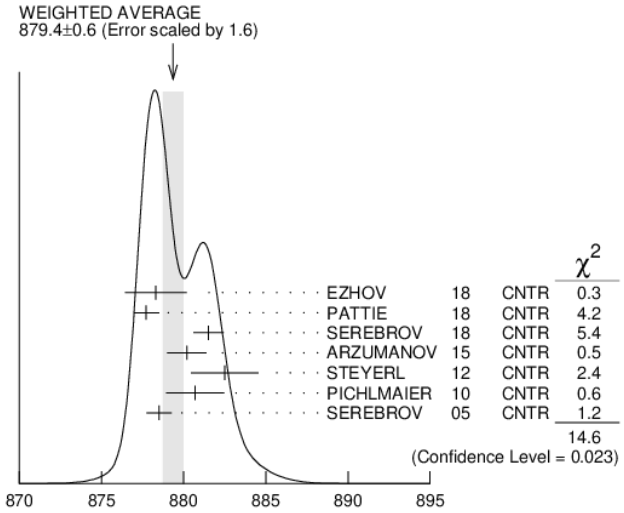


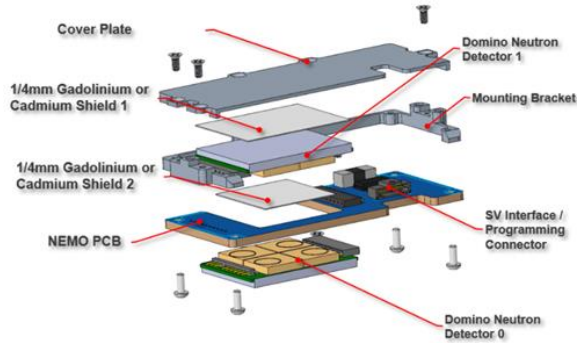
- Intelligence and Space Research (ISR)
  - Space Science & Applications (ISR-1)
  - Dr. Kurtis Bartlett, Dr. Karl Smith

- Research
  - Neutron detector efficiencies for moon orbit mission
  - Work at UTK: Neutron detection and radiography

Research Overview and Motivation

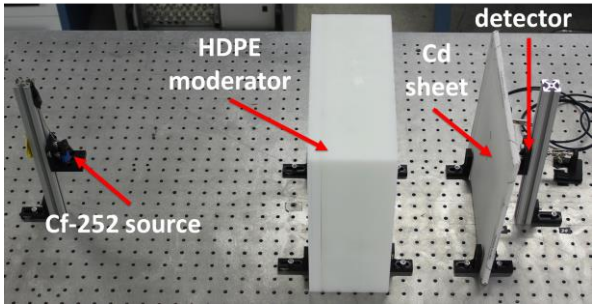
- **Neutron lifetime measurements disagree**
  - Plot from the Particle Data Group
- **Differences stem from “beam” vs “bottle”**
- **New idea: space as a form of containment**
  - Thermal neutrons from moon’s surface
- **Neutron-lifetime Experiment in the Moon's Orbit**
  - CubeSat ride-along
  - Domino neutron detector on board
- **Need to validate the detector’s efficiency**
  - RDT data only based on MCNP simulations





Research Approach

- **Combined simulation and physical approach**
  - MCNP: Energy-dependent flux
  - Physical: True count rates
- **Take several measurements**
  - Variable moderator thicknesses
  - Cf-252 source
- **Iterative unfolding process to extract efficiencies**
  - Maximum-likelihood expectation-maximization
  - Monte Carlo methods for uncertainty



$$\begin{bmatrix} x_{1,1} & x_{1,2} & \cdots & x_{1,m} \\ x_{2,1} & \ddots & & \vdots \\ \vdots & & \ddots & \vdots \\ x_{n,1} & \cdots & \cdots & x_{n,m} \end{bmatrix} \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_m \end{bmatrix} = \begin{bmatrix} T_1 \\ T_2 \\ \vdots \\ T_n \end{bmatrix}$$

Summary of Results

- **Figure shows calculated neutron detection efficiencies up to 1 MeV**
- **Agreement with RDT efficiencies**
- **Improvements can be made**
  - Improved physical measurements
    - Reduced environmental impact
    - Longer count times
  - LANSCE
    - Time-of-flight measurements
  - Finer binning